

WHAT IS CLAIMED IS:

1. A method of treating a surface of a sample,
comprising the steps of:

arranging a sample on a stage provided in a chamber;
5 continuously supplying an etching gas into the chamber
and generating a plasma from the etching gas;
applying an rf bias at a frequency of 100 kHz or higher
to the stage independently of the generation of the plasma;
and
10 *(A)* modulating the rf bias at a frequency of 100 Hz to 10 kHz
(B) to perform a surface treatment in which a minimum feature size
is 1 μ m or smaller to the sample.

2. A method according to claim 1, wherein the plasma is
a high-density plasma having an electron density of $1 \times$
15 $10^{10}/\text{cm}^3$ or higher.

3. A method according to claim 1, wherein the etching
gas is a mixed gas of chlorine and oxygen.

4. A method according to claim 1, wherein the step of
arranging a sample on a stage includes holding the sample on
the stage by electrostatic chucking, the sample being treated
by applying the rf bias to the stage independently of the
plasma generation and time modulating the rf bias.

5. A method according to claim 4, wherein the electrostatic chucking of the sample is effected by a dipole type electrostatic chuck.

6. A method according to claim 1, wherein the sample has
5 a film made of a material serving as a gate electrode on a gate oxide film having a thickness of not greater than 6 nm is etched with the plasma and is also time modulated.

7. A method according to claim 6, wherein the film made
of the material serving as the gate electrode is a polysilicon film or a multi-layered film including a polysilicon film.

8. A method of treating a surface of a sample,
comprising the steps of:

arranging a sample on a stage provided in a chamber;
continuously supplying an etching gas into the chamber
15 and generating a plasma from the etching gas by using
microwaves;
applying an rf bias at a frequency of 100 kHz to 10 MHz
to the stage independently of the generation of the plasma;
on-off modulating the rf bias at a frequency of 100 Hz to
20 10 kHz; and

setting a V_{pp} value of the rf bias voltage in the on state to 100V or higher, whereby the surface of the sample is treated.

5 9. A method according to claim 8, wherein the plasma is an ECR plasma using microwaves of 2.45 GHz.

10 10. A method according to claim 8, wherein the plasma is an ECR plasma using microwaves of 100 MHz to 1 GHz.

11 11. A sample surface treating apparatus comprising:
a stage which is provided in a chamber and on which a
sample to be subjected to a surface treatment is to be placed;
etching gas supplying means for continuously supplying an
etching gas for plasma generation into the chamber;
plasma generating means for generating a high-density
plasma in the chamber;
15 a bias power supply for applying a bias voltage of 100
kHz or higher to the stage independently of the plasma
generation; and
pulse modulating means for modulating the bias power
supply at a frequency of 100 Hz to 10 kHz,
20 wherein a surface treatment in which the minimum feature
size is 1 μm or smaller can be performed on a sample placed on
the stage.

12. An apparatus according to claim 11, wherein an amplitude of the rf voltage of 500V or higher can be generated when the frequency of the rf power supply is 15 MHz or lower, and an amplitude of the rf voltage of 800V or higher can be generated when the frequency of the rf power supply is higher than 15 MHz.

13. An apparatus according to claim 11, wherein the high-density plasma is generated by one of an Electron Cyclotron Resonance system and an Inductively Coupled Plasma system.

14. A sample surface treating apparatus comprising:
a stage which is provided in a chamber and on which a sample to be subjected to a surface treatment is to be placed;
etching gas supplying means for continuously supplying an etching gas for plasma generation into the chamber;
plasma generating means for generating a high-density plasma in the chamber by using microwaves;
a bias power supply for applying a bias voltage of 100 kHz to 10 MHz to the stage independently of the plasma generation; and
pulse modulating means for modulating the bias power supply at a frequency of 100 Hz to 10 kHz,

wherein the amplitude of the rf voltage as the bias power supply is set to 100V or higher.

5 Sub B' 15. An apparatus according to claim 14, wherein said plasma generating means uses electron cyclotron resonance by using microwaves whose frequency is 2.45 GHz.

16. An apparatus according to claim 14, wherein said plasma generating means uses electron cyclotron resonance by using microwaves whose frequency is 100 MHz to 1GHz.